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BY

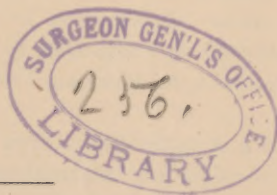
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WATER POLLUTION—WELLS.

Poets have sung of the “babbling brooks” and the “mountain springs” with their “silver cascades.” Painters have sketched

“the placid stream,
Reflecting back the mirrored beam,”

in many a sequestered nook, where the beauty of the scene gave to the soul its grandest appreciation of nature’s handiwork; but the poet’s song and the painter’s canvas are too often the false airs and the tinsel drapery of Momus—fun and folly. But poets and painters live in a realm uncongenial to the startling facts of modern chemistry. Virgil would undoubtedly have been as ready to have believed that H^2O represented a glass of milk, as that it was the equivalent of pure water; while, if Raphael had been told that the pool of Bethesda was abundant with “albuminoid ammonia,” he might innocently have believed it to be “something good to eat.”

Tradition and popular education have taken wings in a tangent direction from many of the fundamental principles of a natural existence, and, while freighting the popular mind with its bulky chaff, sparsely grained, they seldom recognize the revelations of science. The plot of some well drawn novel, or the fascinating performances of its hero, rest unforgotten in the embrace of memory,—are sought after, cherished, and remembered in all and by all ages. Science as yet is but little courted, much less wedded to the popular taste, and the stubbornness of facts is in direct ratio to the inflexibility of the public mind.

Science, however, is not always of one hue. It is full of attractions and alluring fascinations. It needs only to be clothed in well cut and fashionable garments, and properly and politely introduced, to receive universal recognition and popular applause. This is especially true of the science of sanitation, because it is more closely allied to the vital interests of every community and every family than all others, and, through the simplicity of its primary principles, can be realized and understood by all.

Pure water is essential to the health and comfort of every community: there is no argument to the contrary. How such a *desideratum* can be acquired and maintained is a problem which requires the closest application of science, as well as mechanical and engineering skill. The question, whenever and wherever applied, becomes an isolated reality, and the solution, instead of being based upon established formulas or analogy, is almost wholly dependent upon the individual facts and conditions connected therewith.

The aspect of the question a century hence will be very different from what it is to-day, even as in its present bearings it differs from the time when the woodman's axe was the only sound of industry that echoed through the sleeping valleys and over the watchful hills of New Hampshire. In that day the hardy pioneer quenched his thirst by the side of any stream or spring with water as pure as earth could give. He thought not to glance up the stream to see if it was spanned by a family vault, or flanked by a barnyard. Likewise, if he partook from the bubbling spring or the primitive well, he never imagined a crystal of urea came up in the tiny fountains of sand at its bottom, or that the sparkle of the water was the carbonic acid of a sink drain; for around him were no such dangers. But civilization (in many respects a misnomer) came on, and brought with her more evils than one,—seduced the virginity of nature, and begot a host of illegitimate products and conditions. Into her very veins—the streams and rivers—have been injected the effete products of waste and decay; and to-day her very gifts, poisoned by men, bring pain, poverty, tears, and death into many households.

We have all, no doubt, traced some cases of the zymotic

order to polluted water, with evidence that left no doubt as to the correctness of our conclusions. As to how far such influences extend in the causation of disease is undetermined, but I believe it extends far beyond the category of acute zymotic diseases.

What of the great invalid corp that register their physical afflictions under the comprehensive term "poor health," and who seem to have no specific disease, either acute or chronic? What demon has laid so oppressive a burden upon the nerve centres that half of life's function is smothered, and the physical energies nearly blotted out? I believe that contaminated water is one of the prime factors in this unfortunate and distressing aggregate. We have often traced typhoid fever, dysentery, and other diseases to a polluted well or spring; but the cause of insidious decay, progressive pallor, softening muscles, wasting strength, and slow enervation is not so readily found nor so zealously sought after. That contaminated water should produce such results, associated perhaps with other unsanitary surroundings, there can be no argument to disprove. A close study of the subject for the past two years has led me to believe that polluted wells are a most prolific source of sickness and death throughout the state. I believe the medical profession is not yet so thoroughly aroused upon this subject as the facts demand, and that if the physicians of the state should carefully investigate the question of water pollution, the result would be one of wide-spread alarm at the ravages it is producing.

By far the most dangerous source of water supply is the well, because of its close proximity to dwellings. If the surroundings of a well are not free from all impurities and waste, we have no right to expect pure water, and an attack of typhoid fever, dysentery, or kindred diseases should not in the least astonish us. *Conditions which endanger our wells are the rule and not the exception, both in the sparsely settled country and in the city.*

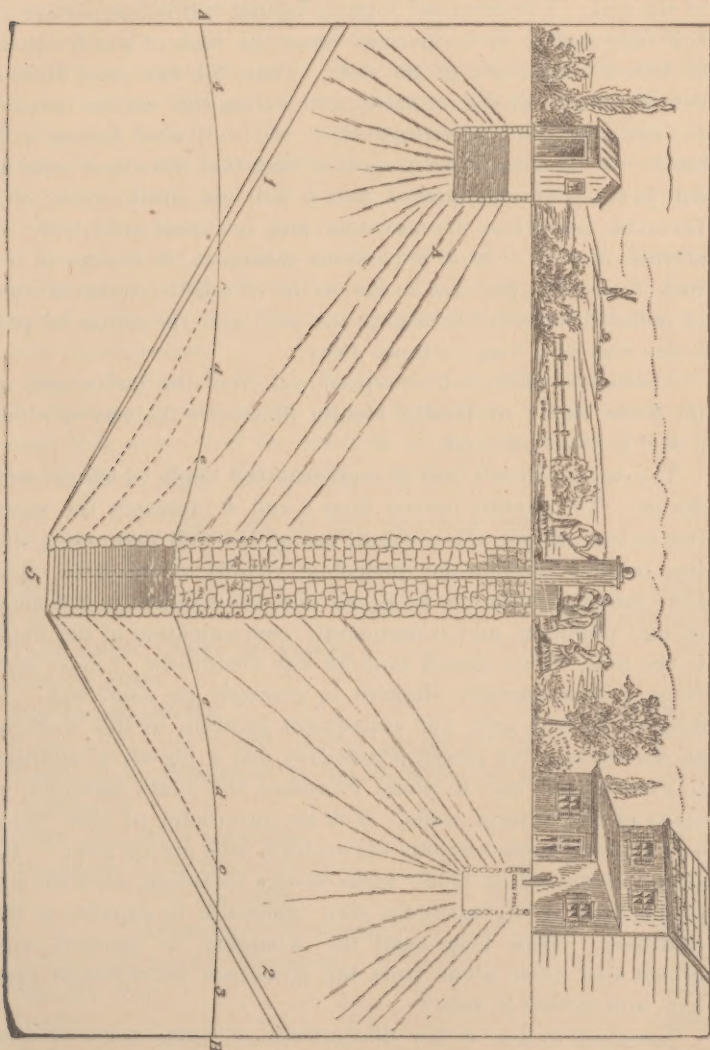
In a speech before the Central N. Y. Medical Association in 1875, Dr. Harvey Jewett said,—

"We are often asked, In what way does the water of our wells, in farming communities especially, and in our larger villages,

become impure? It comes bubbling up from the deep fountains, fresh, cold, pure, and clear as the crystal, and often gives no indication by taste or smell of containing impurities. How often do we see the waste water from our kitchens thrown out upon the ground year after year, until the soil is saturated thereby! Then, again, the continuity of sink-drains, cess-pools, and privy vaults to our wells is sufficient to saturate the earth with their poisonous, disease-producing elements. It is through the agency of this apparently *pure water*, constantly, insidiously introducing these subtle elements into the human organism, that the fountains of life are poisoned and disease generated. In large towns and thickly populated streets, with slovenly domestics, the whole surface becomes saturated with the waste water, and in wet seasons the well, being the only artificial drainage, receives the drippings, converting it into a cess-pool of filth. I have known instances where the waste water from the sink-drain ran directly into the well, until the horrible stench compelled an investigation and a remedy. Instances of this kind are by no means rare, where a direct communication from the sink to the well is found to exist. With some families in the country the whole waste water of the household is thrown out upon the ground, until the entire surface soil is saturated like a sponge with the elements of disease. The popular but erroneous idea, that filling in earth upon a water-saturated soil removes the necessity of deep drainage, should be exploded from the minds of the people, and the great central fact set forth, that no water-saturated soil is fit for human habitation, and that a large proportion of unhealthfulness and human ailments can be traced directly or indirectly to this influence."

I have had forwarded to me during the past year many samples of well water from different sections of the state for examination, and *over ninety-five per cent. were contaminated*. In many instances no particular suspicion existed that the wells were polluted, so "sweet and sparkling" was the water. With the exception of a few wells in this city, the samples came from the smaller villages and isolated farm-houses. I suspect, and my experience is in accord with the idea, that the most dangerous wells are to be found at the latter, because such a well is subjected not only to the unsanitary influences of the household,

but of the barns, cattle-yards, hennery, pig-sty, etc. No one can reasonably presume that a well situated in close proximity



to such surroundings can long remain pure, except that its altitude is such as to render contamination impossible, which is rarely the case. It should be borne in mind that a well is in

itself a system of drainage for a given area of the earth, which area is dependent upon the depth of the well and the character of the soil. The accepted formula is, that it drains a portion of soil represented by an inverted cone, the base of which equals in diameter the depth of the well. Thus, the well *must* drain a certain amount of soil or earth, and unless this certain amount is kept clean and uncontaminated, the well *must become polluted*. It should not be forgotten that this described cone of soil is the *minimum* amount that a well can drain, while with favorable conditions the maximum area is almost unlimited. A stratum of clay or other impervious substance, or fissures in the rock formation, may act as the carrier of a little stream or vein of polluted water till it reaches the well, and the source of pollution may be a long distance away.

The sketch which is here reproduced from the last report of the State Board of Health vividly illustrates the way in which a well is often polluted.

The double lines 1 and 2 represent the angle which the well drains. The slightly curved lines 3 and 4 represent the water line in the ground, the constant use of the well depressing this line below a level in the immediate vicinity of the well. The lines radiating from the cess-pool and vault illustrate the cause of said pollution, and consequently contamination of the water in the well. This sketch is in no way overdrawn: I have seen many wells apparently situated in precisely the same way. If somewhere in a near and convenient location to this well, as shown above, were placed a barnyard and a pig-sty in addition to what we now see, it would represent the exact condition of many of our farmers' wells. Yet the proprietor of this "best well in town" wonders why his doctor's bills are so large! He bows "to the will of God" when cholera infantum takes the life of his little child, when his own ignorance or cupidity is the destroyer. How long shall the Almighty be charged with crimes that come alone from the ignorance, carelessness, neglect, and conceit of men?

I propose to give a few illustrations of water pollution that are of a very marked character. The following diagram is that of a hotel in one of the thriving towns in this state, and the facts connected therewith I obtained from a reliable physician

under the promise of not giving to the public the locality or his name. I have seen the hotel myself, and assure you that the location was as represented.

A case of typhoid fever occurred the past season (1882) in the bed-room near the privy (see diagram No. 1). All the discharges from this patient were thrown into the vault without being disinfected. This vault was located about *fifteen feet from the well* which supplied this house. Result: *Fourteen cases of typhoid fever, with one death, from the use of this water for drinking purposes.*

The following description and history of a well in Newport (although I published the same in the last report of the State Board of Health) is of such a remarkable character that it will bear republication.

The attention of Dr. D. M. Currier was directed to this well in the investigation of the cause of sickness in the family that used this water, and the analysis which is given of the water was made by Prof. Edmund R. Angell of Derry.

ANALYSIS OF THE NEWPORT WELL.

Odor,	slight.
Color,	a little yellowish.
Total solids, grains per gallon,	49.2
Soluble solids,	34.7
Ignition of residue,	it blackens.
Combustible and volatile matter, grains per gal.,	9.24
Hardness, equivalent to grains of CaCO_3 per gal.,	11.00
Alkalinity, " " " "	15.00
Chlorine, grains per gallon,	12.00
Ammonia, parts per million,—	
Free ammonia,	0.0666
Albuminoid ammonia,	0.3100
Nitric acid, grains per gallon,	2.69
Nitrous acid,	none.
Iodine,	none.
Bromine,	none.
Iron,	very slight trace.
Copper and lead,	none.

Microscopic examination of sediment shows,—

Bacteria :

Bacteria Bacillus.

Bacteria Vibrio.

Infusoria:

Flagellata Monadina.

Flagellata Euglenia.

Ciliata Enchelia.

Ciliata Bursarina.

Ciliata Parmecia.

Silicious granules.

Small pieces of decaying wood.

ADDITIONAL FACTS.

Free carbonic acid, grains per gallon,	11.9504
Combined CO_2 " " "	6.6528
Total CO_2 " " "	18.6032

Bases : Lime, magnesia, soda, potassa, ammonia.

Acids : Hydrochloric, sulphuric, nitric, phosphoric, carbonic, silicic.

Most of the lime is in the form of carbonate held in solution by carbonic acid: most of the magnesia exists as a salt soluble in water, probably the sulphate: some of the alkalis are present as carbonates. The iron is kept in solution by carbonic acid.

EXPLANATION AND OPINION.

The color and odor indicate contamination. The large amount of soluble solids is suspicious. The blackening of the residue during ignition shows the presence of organic matter in solution. The large amount of combustible and volatile matter is a grave indication. Because the alkalinity exceeds the hardness, it shows the presence of an alkaline carbonate, which is a suspicious circumstance, since it may result from the decomposition of animal matter. The amount of chlorine is unusually large. I think the average for well water is about one grain. The large quantity of chlorine and the presence of

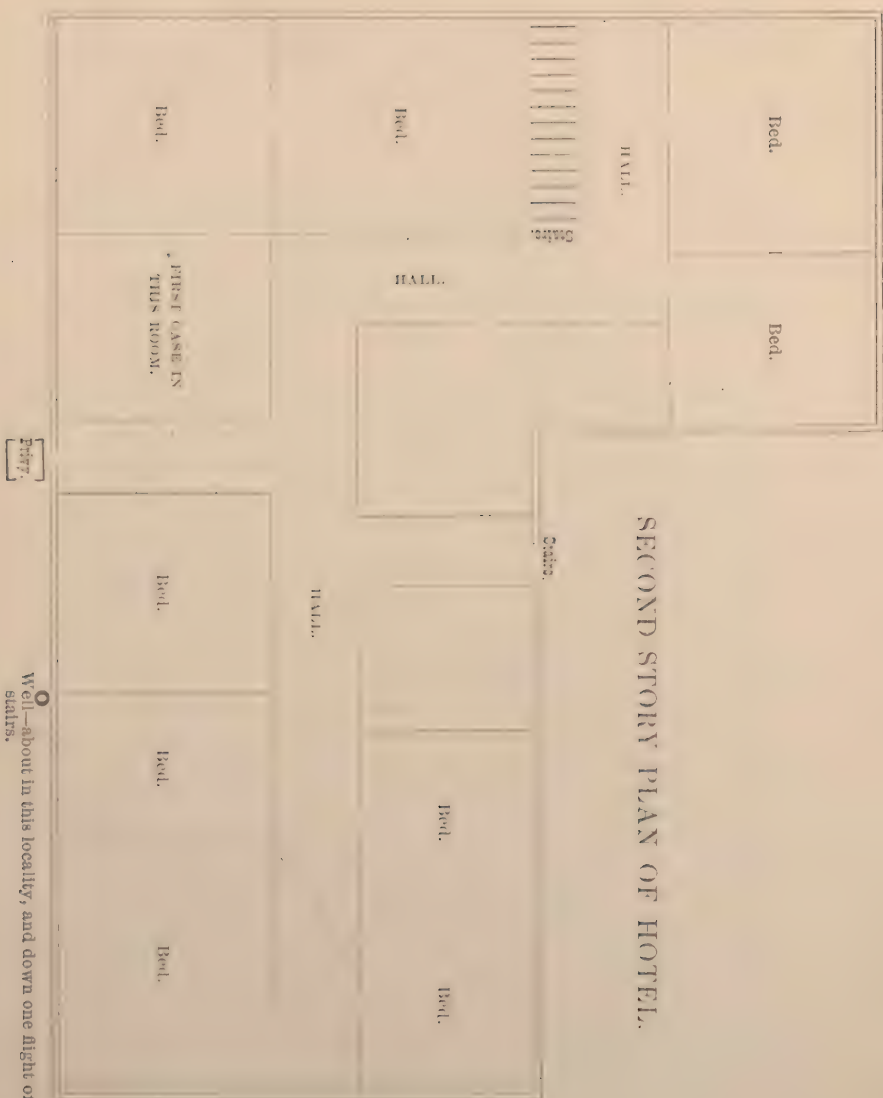


DIAGRAM NO. 1.

alkaline carbonates point very strongly to the stable, privy, sewer, or cess-pool. The amount of nitric acid is large, though this alone may not mean much, yet joined with the other results it has much significance. The amount of ammonia is more than twice the quantity that ought to condemn a water absolutely. The small amount of free ammonia and the large quantity of albuminoid ammonia show that a large amount of organic matter is present and decaying slowly. As the weather becomes warm, the proportion of free ammonia will increase. Bacteria are always associated with putrefaction and conditions of hygienic importance.

Infusoria are never generated except in organic solutions. They are abundant in all fresh water wherever organic matter is held in solution, also in stagnant water.

From the large amount of chlorine and the presence of alkaline carbonates, it would appear that the water is contaminated with animal rather than with vegetable matter.

This water is unfit for domestic uses.

EDMUND R. ANGELL.

A word in explanation may be necessary to those who are not familiar with water analysis.

Water that contains such a large amount of solids is very suspicious. It will be seen that the sample contained twelve grains of chlorine to the gallon, which would alone at once condemn it. The only source from which chlorine is derived in the waters of this state, except possibly a trace, must be from the sewage or waste from the household, where common salt is used. A well that contains over one grain to the gallon is to be looked upon with suspicion. The same is true of a water that contains over 0.01 part of ammonia or "albuminoid ammonia."

Then, again, the bacteria and infusoria, to the extent present, indicate its pollution.

Of the history of this well and the family using its water Dr. Currier renders the following report, which is a terrible commentary upon the dangers of filth in drinking-water. Since the report was made, Dr. C. states that there was a case of typhoid upon these premises during the early part of the

winter, which he did not know of at the time his report was written.

DR. CURRIER'S REPORT.

The farm-house, from the well of which was taken the specimen of polluted water, is situated on a high bluff of land south-east of the village, and is known by the name of East Mountain. Upon this ridge of land are situated some of the best farms in town. The soil is rich and deep, underlying which is a sub-soil of clay, very hard and compact, but occasionally interrupted by a deposit of sand. I have been told there were beds of sand in the vicinity of this dwelling-house.

By the diagram sent, you will see that the well is under the L part of the house. The water is drawn up by means of a windlass in one of the back rooms. The well itself is some twenty-five feet deep. In the summer kitchen, not more than three or four feet from the well, you will notice the sink marked 2 on the diagram, which discharges its water on the ground by means of an open spout but a few feet from the outside of the building. At 3, about an equal distance from the well, is a back door, from which foul water, as on washing-days, and filth of nearly all descriptions, were usually thrown, which is not saying more than can be said of back doors to farm-houses in general.

As you step out of this door, a little to your left you will see the pig-sty, the centre of which cannot be more than fifteen feet from top of well. The privy marked 4 is entered from the walk leading from the well-room to the barn-yard, the excrements of which are received upon the ground. The distance from the door, 7, that opens into the barn-yard, and the well, is just twenty-four feet by actual measurement. Stepping out of this door you are in the barn-yard filled with cattle and sheep, on the further side of which is the barn with its usual manure heap and decomposing vegetable matter in general. Thus we have the barn, barn-yard, privy, pig-sty, back door, and sink all in dangerous proximity to the well, either one of which might contaminate its water, and render it unfit for use.

It was on the 8th of March, 1883, that I procured the second specimen of water from this well that I sent you. For over

three months prior to that date the ground had been frozen and covered with snow, with no thaws during the whole winter severe enough to cause any surface-water. The winter was what is called a dry one, all the wells in that vicinity being remarkably low, so that there could be no surface-water finding its way into the well on that date, and probably had not for months previous: the influence of the surroundings at that time must have been at the minimum. If the water is bad under this condition, what must it be soon after the frost is out, and the well becomes filled with its maximum of surface-water?

Now the interesting question comes, What has been the effect upon the health and lives of the family or families occupying this house and using this water? I am informed that they did not use the water at all times, under suspicion that it might not be good: still it was used more or less.

Forty-one years ago the place was purchased and occupied by a man then in the prime of life. He had seven children, some of whom were born before and some after moving upon the place. The father, mother, and all the children are now dead, except one.

The date, age, and cause of death, as near as I can find out, are as follows:

1849, a son, age 18 years; cause, typhoid fever.

1849, a daughter, age 16 years; cause, typhoid fever.

1863, a son, age 28 years; cause, consumption.

1871, mother, age 63 years; cause, gall stones; great sufferer from sick headache.

1874, a daughter, age 27 years; cause, consumption.

1878, a son, age 37 years; cause, consumption.

1879, a daughter, age 34 years; cause, consumption.

1879, father, age 76 years; cause, old age, feeble a long time.

1883, a son-in-law, age 47 years; cause, bronchial consumption.

This last was the only one of whom I had charge, and it was during one of my professional visits that I discovered the situation of the well. One of the first things of which he complained was sore throat and hoarseness, laryngo-pharyngitis. At the

same time he was troubled with an eruption. I never saw it, but as he described it I should say that it was erythematous in its nature. If he exercised so as to perspire, or took hot drinks, it would make its appearance, causing the surface to itch and feel very uncomfortable.

During the spring and summer of 1882 he was under the care of various physicians, both regular and irregular, until the first of October of that year, when he came under my care, at which time he was troubled with cough and hoarseness, it being with difficulty that he spoke aloud. The stomach was very irritable, frequently rejecting food, and more often his medicine. Once when he was in my office for the purpose of consultation, I inquired in regard to his drinking-water. He told me that it was "splendid water," and all right; that he drank a great deal of it. At various times during the fall and early winter he would seem to improve, when some imprudence on his part would put him back. Finally he grew worse, as manifested by failing strength, loss of appetite, and by coughing and raising more, until his death.

The sputa was very tenacious, and at last was quite thick, and composed almost entirely of pus. A few weeks before he died I examined his chest thoroughly. There was no dulness over either lung, and he could fill both of them equally well. Auscultation revealed very heavy, moist rales.

About five weeks before the death of the father,—that was some time in January,—I was called to the house to attend his son, a lad six years of age, with dysentery accompanied with petechial eruption over the limbs and body. He recovered slowly. In about two weeks two other sons, aged respectively eight and ten years, came down in the same way with dysentery and the eruption, causing them to scratch vigorously. The mother was troubled with the eruption, but no dysentery.

D. M. CURRIER.

THE RYE BEACH WELL,

which has attracted considerable attention the present season, and been the source of many false newspaper reports, is most remarkable in the history of water pollution. Briefly, the history connected therewith is as follows:

A wealthy Philadelphian by the name of Lewis, who has spent his summers at this noted beach for the last twelve years, bought last spring a lot of land, and built a very expensive and elegant summer residence. The location was upon an elevation some forty or fifty feet higher than the sea, and but a short distance from the water. This elevation is made up mostly of seamy ledges, with but a few feet of soil covering the same. From a sanitary point of view, no better site could possibly be selected.

Instead of building a sewer to the ocean for drainage purposes, he constructed a cess-pool forty feet distant from the house, into which all the sewage from the house ran. In building this cess-pool it was necessary to excavate three feet of the ledge to get a good and sufficient depth. Sixty feet from this cess-pool, and apparently upon the same level, was dug the well which was to supply this residence with water. After reaching the ledge, it was necessary to go ten feet into the rock to get sufficient water, which was obtained in abundance, and was excellent in quality. The well and cess-pool were both constructed at the same time, and in *two weeks after, the well was polluted by this cess-pool*. The family, not realizing the source of pollution or its danger, continued to use the water for a short time afterwards, or until it became so tainted that it was repulsive to the senses of taste and smell. The result was the death of Mr. Lewis, and a lady visitor who lived in the vicinity and frequently drank of this water, and a severe illness of a daughter of Mr. Lewis, his servant, and a guest of the family. These seemed to be cases of blood poisoning, the severer ones resembling in their last stage typhoid fever.

This instance of well pollution illustrates the fact that a rock formation, though generally believed to be the best safeguard against the contamination of a well, may be the most dangerous. The seams which existed in this ledge no doubt served as direct channels to convey the filth to this well.

The following instance of well pollution seems to illustrate in what unsuspected ways water may become contaminated:

A short time since, Dr. C. A. Wood, of Greenville, sent me several specimens of water for examination. The contamination of some of them was of such a character that I asked him

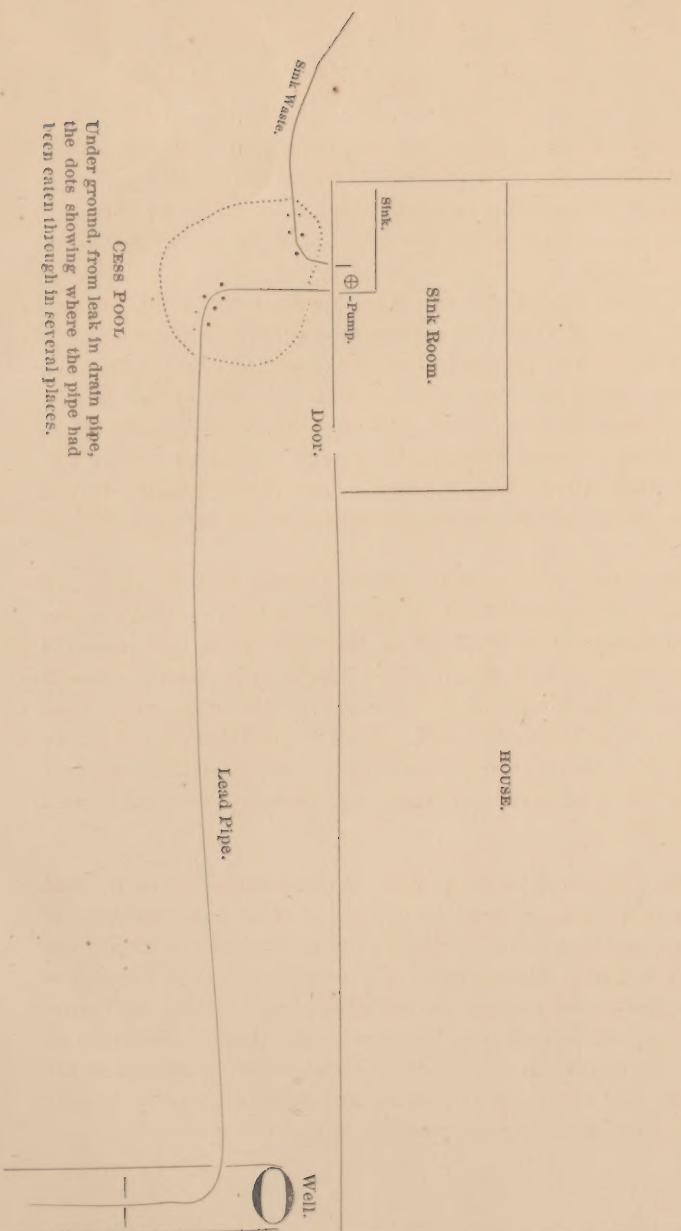
for a history of the samples. I will here state that the specimens marked "No. 2" and "No. 3" were both badly polluted, and with different substances, so that, in testing, the chemical reactions were quite different. In his reply to my letter of inquiry he says,—

"The water I sent you last week marked No. 2 was dipped directly from the well, as shown in diagram, while the water marked No. 3 was pumped from the pump. The family have been sick more or less ever since they occupied the house. *None of them have been well*, but it is exceedingly difficult to give a name to their complaints, except a general out of fix, with a dull, tired feeling, headaches, sore throats, furred tongues, &c., but no downright sickness so as to prostrate them."

It will be readily seen by the crude diagram that the cess-pool filth which had accumulated around the lead pipe leading to the well, by reason of a breakage in the sink-drain, had corroded the water-pipe till it was full of small holes, which allowed this filth to be drawn in and mixed with the water every time any was drawn from the well. Such a condition is not likely to be of very frequent occurrence, but it demonstrates the fact that the source of water pollution may be sometimes subtle and unexpected.

In the foregoing paper it has been my aim only to present some points that will lead to a more careful consideration of this all-important subject, rather than to discuss the topic from a purely scientific standpoint. To awaken a deeper interest in the prevention of disease is necessary both in the profession and among the people, and I sincerely hope the medical men of our state will become the instructors and the guardians of the public to the extent that unnecessary sickness may be largely averted, and nature's gifts received in nature's purity.

DIAGRAM No. 3.



Cess Pool
Under ground, from leak in drain pipe,
the dots showing where the pipe had
been eaten through in several places.

Back House,
or Privy, 10
ft. from well,
and torn a-
way only last
year.

